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Research Article

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The Effect of Task-oriented Training on Mobility Function, Postural Stability in Children with Cerebral Palsy

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| Abstract |

PURPOSE: The purpose of this study is to examine how task-oriented training focused on lower extremity strengthening can affect mobility function and postural stability.

METHODS: The study's subjects included 10 children with cerebral palsy: 7 girls and 3 boys between the ages of 4 and 9 whose Gross Motor Functional Classification System (GMFCS) level was I or II. Their functional mobility was gauged using the Gross Motor Function Measurement (GMFM), and their postural stability was evaluated using a force platform. Participants received task-oriented training focused on lower extremity strengthening for 5 weeks. The study used a paired t-test to investigate the difference in mobility function and postural stability of children with cerebral palsy before and after the lower extremity strengthening exercise.

RESULTS: The GMFM dimensions D (standing) ($p<.02$) and E (walking) ($p<.001$) improved significantly between the pre-test and post-test. A significant increase in the posturographic center of pressure (CoP) shift and surface area of the CoP were found overall between the pre-test and post-test ($p<.001$).

CONCLUSION: The present study provides evidence that an 8-week task-oriented training focused on strengthening the lower extremities is an effective and feasible strategy for improving the mobility function and postural stability of children with cerebral palsy.

Key Words: Cerebral palsy, Functional mobility, Postural stability, Task-oriented training

Ⅰ. Introduction

Cerebral palsy results from a brain lesion in the developing fetus or infant and it belongs to a group of disorders involving non-progressive disturbance. Cerebral palsy affects movement and posture development and creates limitations in activity (Bax et al., 2005). Motor impairment restricts children with cerebral palsy from participating in physical activity in their daily living (Thorpe, 2009). Improvement of mobility function is one of the main goals of rehabilitation for children with cerebral palsy. Adaptation to changes in functional condition requires the use of diverse physiotherapeutic techniques (Papavasiliou, 2009). Recently, there has been increasing evidence that proves the effectiveness of functional therapies based on activity

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enhancement for increasing the functional level of child patients with cerebral palsy (Vincer et al., 2006).

The current understanding of motor learning assumes that repetitive task-specific training can significantly improve motor function (Barbeau, 2003; Lee and Choi, 2013; Schneiberg et al., 2010). This is because improvements in motor function are relevant to task-specific activities. A number of recent studies have evaluated the effects of task-oriented training or similar programs that include the practice of functional activities. These studies report that task-oriented training intervention is an effective approach for enhancing the functional condition of those with disorders of the central nervous system.

A study that implemented task-oriented training intervention with preschool children with cerebral palsy reports significant improvement in the performance of daily activities, including gross motor function and social function (Ahl et al., 2005). Another study reports that muscle strength and functional performance improved after functional exercise training, which included treadmill walking, walking up and down stairs, and sit-to-stands, and that the improved muscle strength and functional performance persisted as time went by (Blundell et al., 2003). A study that applied an exercise program in a functional circular form to adolescents with cerebral palsy reports an improvement of muscle strength, function, and fitness (Mulligan et al., 2004). Despite the small number of studies on the effects of task-oriented training in children with cerebral palsy, it is commonly suggested that task- oriented training can improve muscle strength and functional ability.

However, there is insufficient proof that task-oriented training focused on strengthening the lower extremities can improve mobility function and postural stability of children with cerebral palsy. Postural control is fundamental to motor function and it is related to almost all kinds of motor tasks (Ko et al., 2010). The development of postural stability is important not only for implementing coordinated motor behavior but also for learning motor skills that become increasingly complicated (Chen and Woollacott, 2007). This study attempted to discover how task-oriented training focused on strengthening the lower extremities can affect mobility function and postural stability.

Ⅱ. Methods

1. Study subjects

Subjects were selected from among children with cerebral palsy who are receiving therapy at Center P. Ten children (7girls and 3boys) between the ages of four and nine whose Gross Motor Functional Classification System (GMFCS) level was I or II were chosen as subjects for

Table 1. General characteristics of subjects

Number	Gender	Affected side	Age (yr)	Weight (kg)	Height (cm)	GMFCS level
1	Boy	Bilateral	8	22	116	II
2	Girl	Bilateral	9	22	119	II
3	Girl	Unilateral	5	16	102	I
4	Girl	Unilateral	4	14	96	I
5	Girl	Unilateral	4	14	98	I
6	Girl	Bilateral	9	23	114	II
7	Boy	Bilateral	7	29	119	II
8	Girl	Bilateral	6	20	111	II
9	Boy	Bilateral	4	16	100	II
10	Girl	Bilateral	5	16	103	II

GMFCS: Gross Motor Function Classification System

the study (Table 1). Level I means that a child can walk without restrictions but has limitations in advanced gross motor skills. Level II corresponds to an ability to walk without restriction but has limitations in walking outdoors or in the community.

Inclusion criteria for this study were as follows: 1) children diagnosed with cerebral palsy; 2) children whose Modified Ashworth Scale (MAS) regarding hip flexors, adductors, internal rotators of hip, and hamstring and plantar flexors is level two or below; 3) children with no mental retardation; 4) children who have had no orthopedic surgery or Botulinum toxin injection. Before the experiment, we explained the purpose of this study and obtained voluntary agreement from all subjects.

2. Measurement

Mobility function was measured with the Korean version of the Gross Motor Function Measure (K-GMFM). The GMFM was developed as a criterion referenced test and it is valid for testing the gross motor function of children with cerebral palsy. The GMFM consists of 88 items, which are grouped into the following five dimensions: A) lying and rolling; B) sitting; C) crawling and kneeling; D) standing; and E) walking, running, and jumping. The score for each dimension is presented as the percentage of the maximum score for the dimension. Total score is the average percentage score as measured in all dimensions.

K-GMFM has good psychometric properties. With excellent intra-rater properties, it has a high level of reliability (ICC=.97~.99) (Ko and Kim, 2012).

A force platform (PDM Multifunction Force Measuring Plate, Zebris, Germany) was used to measure postural sway. This device has a platform that is sensitive to pressure and the user can check the visible pressure data where the feet images change. The subjects stood in their bare feet and looked straight ahead with their legs on the platform at shoulder width apart. While the data were recorded, the subjects quietly and comfortably maintained a standing position on the platform. Data collection was repeated three times. An average of the three test results was used for the data analysis.

The task-oriented training focused on lower extremity strengthening was comprised of the following: 1) The subjects maintained a standing position for three seconds; 2) The subjects stood on one leg for three seconds while holding a chair with one hand; 3) The subjects stood up from a chair without using their arms; 4) The subjects stood up from a half kneeling position without using their arms; 5) The subjects kicked a ball; 6) The subjects climbed up and climbed down four steps. All treatment procedures were implemented for 40 minutes, twice a week, for a total of eight weeks.

3. Data analysis

This study used K-GMFM to measure the mobility function and center of pressure (CoP) shift, surface area

Table 2. Posturographic weight-bearing distribution and posturographic CoP shift and surface area of the CoP

Variables		
CoP shifts	SP (㎝)	Sway path length of the CoP
	SDx (㎝)	Standard deviation of x'
	SDy (㎝)	Standard deviation of y'
Surface area of the CoP	WoE (㎝)	Width of the ellipse (medial-lateral sway path of the CoP)
	HoE (㎝)	Height of the ellipse (anterior-posterior sway path of the CoP)
	AoE (㎠)	Area of the centers of pressure (calculated from the CoP shift in such a way that 95% of the data are within the ellipsoid and 5% are outside)

CoP: Center of Pressure

Table 3. Comparison of K-GMFM between pre- and post-training in children with cerebral palsy

Variables	Pre-	Post-	t	p
GMFM (Standing)	69.37±12.45	72.64±12.66	-3.08	.02
GMFM (Walking)	56.34±18.86	59.81±17.76	-3.85	.00

GMFM: Gross Motor Function Measurement

Table 4. Comparison of Posturographic weight-bearing distribution and posturographic CoP shift and surface area between pre- and post-training in children with cerebral palsy

Variables		Pre-	Post-	t	p
CoP shifts	SP (㎝)	259.84±20.97	180.73±21.80	11.91	.00
	SDx	3.35±0.65	2.95±0.65	10.81	.00
	SDy (㎝)	1.48±0.26	1.24±0.25	8.55	.00
Surface area of the CoP	WoE (㎝)	5.67±0.19	4.47±0.34	10.11	.00
	HoE (㎝)	5.84±0.39	4.93±0.21	6.43	.00
	AoE (㎠)	26.50±1.52	13.37±1.56	15.87	.00

CoP: Center of Pressure

of the CoP to measure postural stability (Table 2). Descriptive statistics were employed to explain the study population. The study used the paired t-test to investigate the difference in mobility function and postural stability of children with cerebral palsy before and after the lower extremity-strengthening exercise. The data collected were analyzed using PASW 18.0. The statistical significance level was set at .05.

Ⅲ. Results

Ten subjects participated in the study (7 girls, 3 boys). Participant demographic information, type of cerebral palsy, Gross Motor Function Classification System level were shown in Table 1. The GMFM dimension D ($p<.02$) and E ($p<.001$) improved significantly between pre-training and post-test (Table 3). A significant increase in the posturographic CoP shift and surface area of the CoP were found overall between pre-test and post-test ($p<.001$) (Table 4).

Ⅳ. Discussion

This study was conducted to investigate the effects of a task-oriented training focused on lower extremity strengthening programme on the mobility function and postural stability of children with cerebral palsy. A change in the GMFM score indicates an improvement in the ability to perform gross motor skills, and a change in CoP indicates an improvement in the ability to maintain balance. To conduct appropriate exercises and to participate in regular activities is an important objective of therapeutic intervention for children with cerebral palsy. The possibility of carrying out these elements in a clinical setting is an important factor in program planning. In this study, task-oriented training focused on the strengthening of the lower extremities and was performed for 40 minutes twice a week for eight weeks.

The results of the present study were consistent with the results of a study that investigated the effects of a five-week task-oriented training program for children with

cerebral palsy. The training program included functional activities used in everyday activities. The functional training significantly improved the GMFM score and the ability to perform everyday activities (Salem and Godwin, 2009). In a previous study, a task-oriented exercise program that included functional mobility such as sit-to-stand, step up and down, walking, and running had positive effects on leg muscle strength, balance, walking speed, and walking endurance (Peungsuwan et al., 2017). Gait training on the treadmill improved the isokinetic muscular strength of the children with cerebral palsy and increased the proportion of muscles in their body composition (Cho et al., 2016).

Repeated performance of a task has the potential to train motor performance aspects such as coordination, balance, strength, endurance, and physical conditioning (Bunton et al., 1993). Furthermore, the repetitive performance of a task in an environment related to the task can be improved through effective motor patterns that enable optimum functional performance (Johnson, 1984; Magill, 2004).

Postural control deficits in children with cerebral palsy are determined by the site and extent of the brain damage (Wallard et al., 2014). In these children, the oscillation of the center of pressure in a standing position is largely due to the child's postural control deficits.

cfA large oscillation area suggests a small base of support; it is the base of support that enables one to make postural adjustments and to avoid imbalance (Domagalska-Szopa et al., 2016). In the present study, deficient postural control was observed in the children with cerebral palsy, but their postural stability increased after the task-oriented training. Because a change in postural control determines functional change, increased postural stability is a therapeutic goal for children with cerebral palsy. Furthermore, such a therapeutic intervention will improve their functional level. Postural control deficit is one of the main causes of gait disorders among children with cerebral palsy (Pavão et al., 2014; Stackhouse et al., 2007). Provision of an intervention consisting of task -oriented training to these children improved their balance and walking ability (Peungsuwan et al., 2017). A previous study on the application of a motor program consisting of task-oriented training to children with cerebral palsy also confirmed the effectiveness of task-oriented training in enhancing both motor function and balance abilities (Katz-Leurer et al., 2009).

The findings of this study proved that applying task-oriented training leads to a positive functional outcome. However, one limitation of this study is that the results of the study have a clinical implication because the subjects in the study were children already receiving clinical treatment for their cerebral palsy. Another limitation was the small sample of participants with cerebral palsy. The study might be underpowered for some results, and thus a replication study with a larger sample is necessary.

V. Conclusion

This study provides evidence that an eight-week task-oriented training focused on strengthening the lower extremities is an effective and feasible strategy for improving the mobility function and postural stability of children with cerebral palsy. In the future, further research is required on the effects of training according to the level of GMFM (Gross Motor Function Measure), and on changes in the quality of life of children with cerebral palsy who engage in such training.

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